Exploring the Envelope of a Modified 3° Decelerating Approach for Noise Abatement

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Introduction

Noise Is an Issue

- The impact of aircraft noise in residential communities is a major factor limiting aircraft operations and preventing expansion of airports

Airframe/Engine Noise Reduction Technology

- Great noise reduction achieved over last 30 years
- Now in the period of diminishing returns

Noise Abatement Procedures (NAPs)

- Noise abatement procedures, such as the 3° decelerating approach (TDDA) procedure, provide an effective means of achieving further reductions in the impact of aircraft noise in communities surrounding airports (Clarke & Hansman, 1997)

Introduction (continued)

ATC Obstacle to Implementation of NAPs

- Humans have difficulty manually separating aircraft that are decelerating at different rates during heavy traffic

Flight Operation Uncertainties

- Simulation results show 9 nm initial separation required to satisfy 2.5 nm separation at threshold for B747-400 trailing B737-300 (Ho & Clarke, 2001)
- Equivalent to approximately 1 nm extra projected threshold separation.

Capacity Reduced by ~50% in Current Implementations

- Amsterdam Schiphol
- London Heathrow

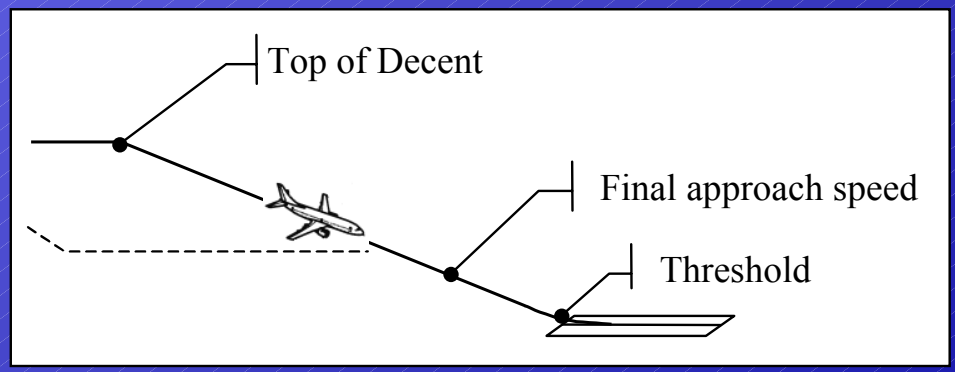
TDDA

The TDDA Procedure

- Start from 7,000 ft (21.8 nm to threshold) at 220 KIAS
- Follow a 3° glide slope with power set to idle
- Upon reaching the final approach speed, re-engage power
- Minimum flap usage throughout the procedure

A Typical Conventional ILS Procedure

- Level off at 3,000 ft, reduce speed to 180 KIAS
- Intercept 3° glide slope



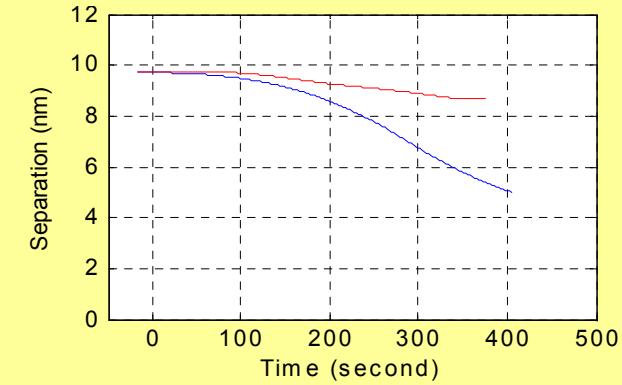
TDDA

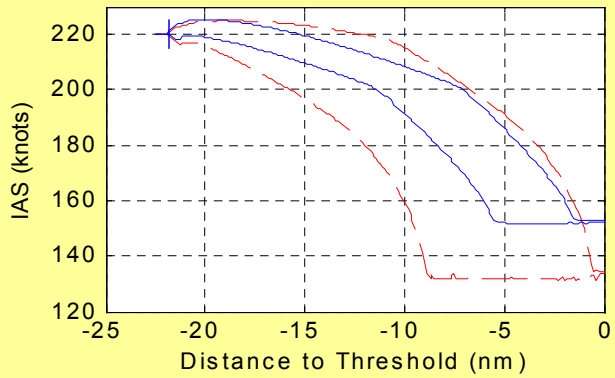
Simulation Results

- Separation

Aircraft	Final	Initial
B747-B737	5	9.7
B737-B747	2.5	9.7
B737-B737	2.5	10.1
B747-B747	4	8.1

- Capacity (B747-B737-B737)
  - Maximum: 41.73
  - TDDA: 24.83
  - 40% capacity loss





B737 Trailing B747

Modified 3° Decelerating Approach (MTDDA)

Motivation

- Mitigate flight operation uncertainties
- Delay deceleration as late as possible
  - Keep aircraft clean
  - Keep engines in idle
- Maximize noise abatement benefits
- Minimize capacity loss

Modifications to the Approach

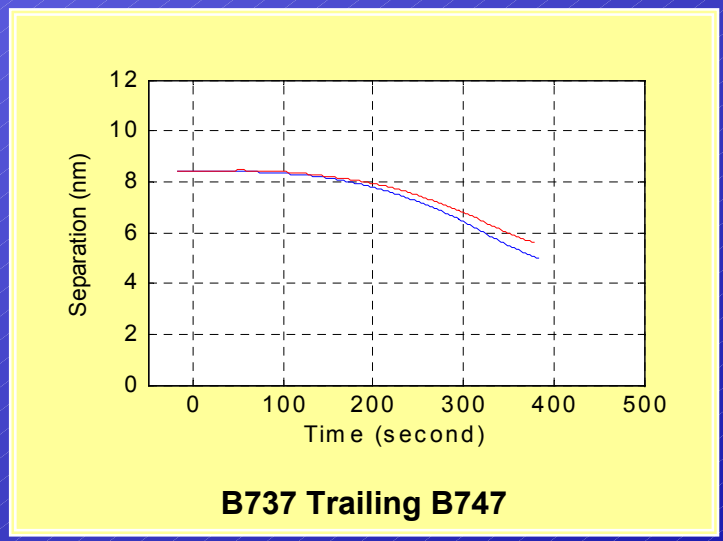
- Hold initial airspeed during initial portion of decent
- Set power to idle after initial speed
- Flap extended 10 KIAS above minimum allowable speed
- Re-engage power upon reaching final approach speed

MTDDA

Simulation Results

- Separation

Aircraft	Final	Initial
B747-B737	5	8.4
B737-B747	2.5	4.7
B737-B737	2.5	5.6
B747-B747	4	6.5



B737 Trailing B747

- Capacity (B747-B737-B737)
  - Maximum: 41.73
  - MTDDA: 39.16
  - Only 6.2% capacity loss

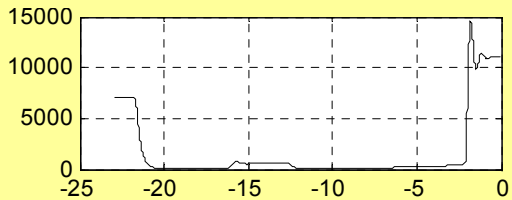
MTDDA

Improvements in Speed Profile

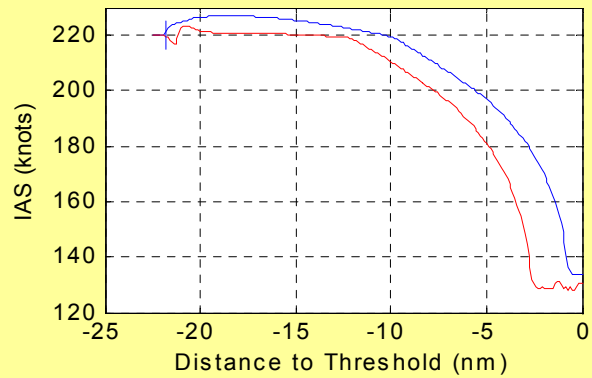
- Final approach speed reached at about 2.5 nm to the threshold
- Smaller variation

Thrust Profile

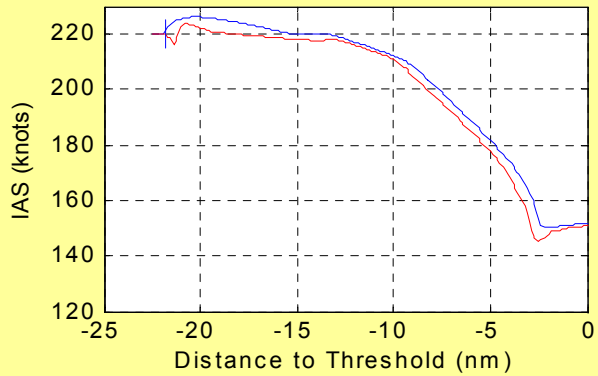
- Still favorable



B737-300

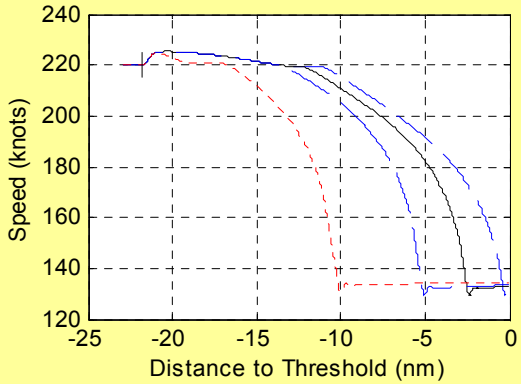


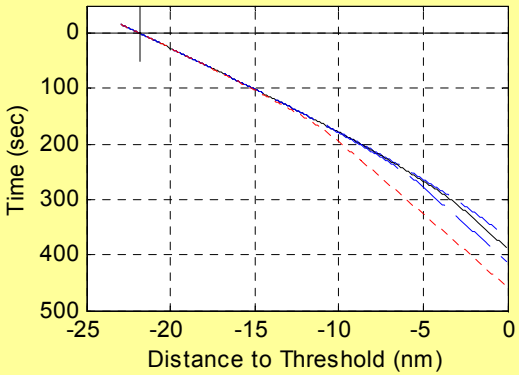
B747-400



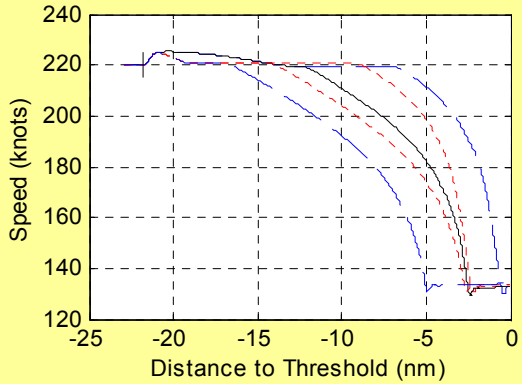
B737-300

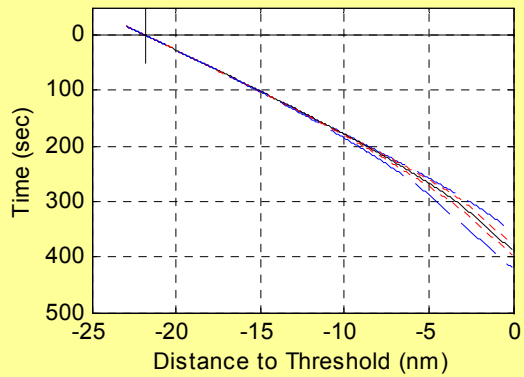
Controllability





B737-300 Simple Control

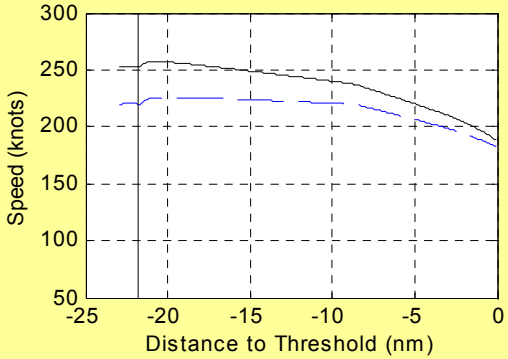




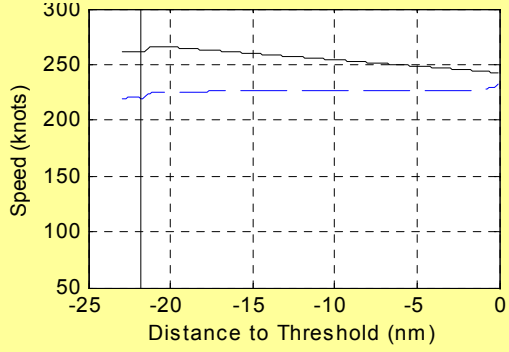
B737-300 Advanced Control

MTDDA Under Wind Conditions

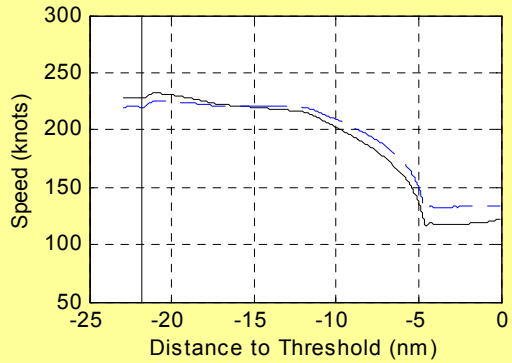
Nominal Flap Schedule



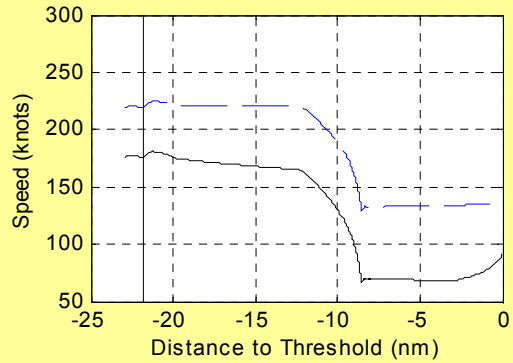
5 Knots Tail Wind



10 Knots Tail Wind



10 Knots head Wind

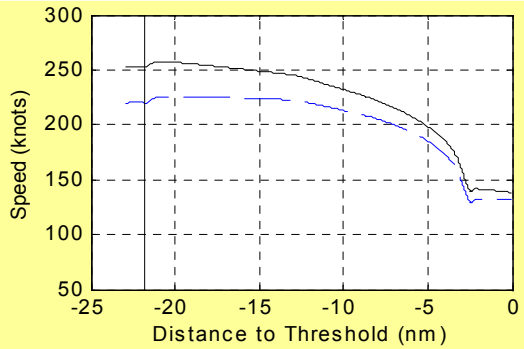


40 Knots head Wind

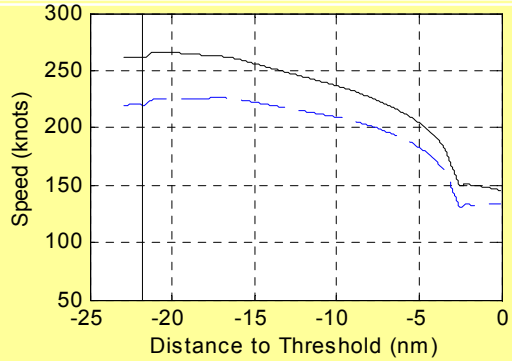
B737-300

MTDDA Adjusted for Wind

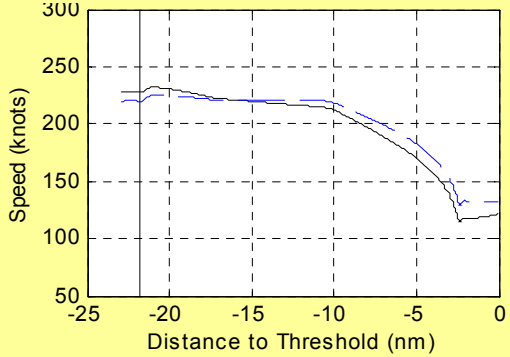
Adjusted Flap Schedule



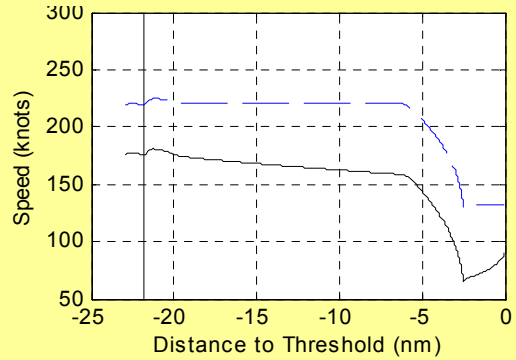
5 Knots Tail Wind



10 Knots Tail Wind



10 Knots Head Wind



40 Knots Head Wind

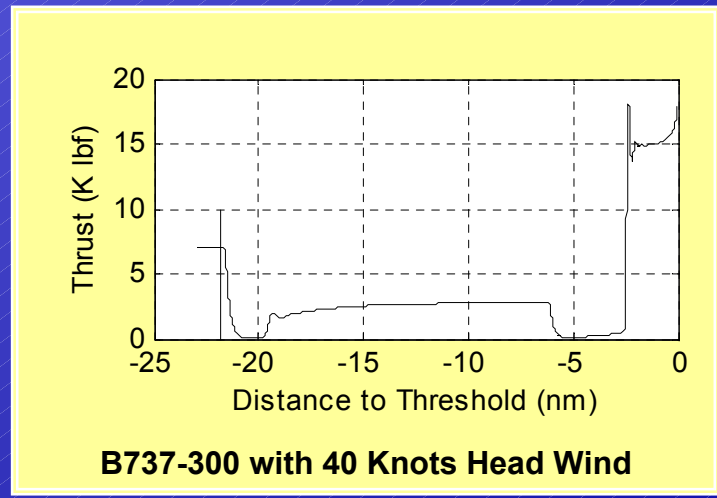
B737-300

MTDDA Adjusted for Wind

Thrust Profile

- 40 knots is the maximum head wind allowing landing to be performed
- Thrust required to hold the initial speed is about 20% of the thrust required to maintain the final approach speed

B757 Basic, Zero Wind (D. Williams)



B737-300 with 40 Knots Head Wind

Summary

TDDA provides great noise abatement benefits, but

- Runway capacity reduced by 40%
- Controllability is limited

MTDDA with its initial speed hold

- Provides same noise abatement benefits
- Greatly mitigates flight operation uncertainty
- Runway capacity only reduced by 6.2%
- Provides better controllability
- Able to accommodate a large range of wind conditions without sacrificing noise abatement benefits

MTDDA Simplifies the Separation Assurance

- Separation profiles display “closing” characteristics, i.e. the minimum separation will occur at the threshold.
- Predicated threshold separation is the main reference

Future Work

Optimize Initial Speed and Initial Altitude

Develop Cues & Algorithms for the Controller to Determine Initial Separation

- Different wind conditions; aircraft equipage; curved approach path

Develop Cues & Algorithms for Flap Extension

Human Factors Related to Advanced Noise Abatement Approach Procedures

- The assignment of responsibilities
- Communications
- Display and automation tools for controllers